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STUDIES IN THE GENUS *HEVEA* VII

BY

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IN the course of my studies towards a monograph of the genus *Hevea*, isolated but significant observations frequently accumulate. In order that these data may be available before the completion of a final monograph, I have initiated a series of articles in which the results of field and herbarium investigations may be published. This paper continues the series and consists of miscellaneous taxonomic, nomenclatorial, phytogeographical, historical and chemical notes.

The herbarium studies herein reported were carried out in 1950, during my visits to important European botanical centers.

The chemical examinations were made by chemists in the United States Department of Agriculture and at the National Bureau of Standards on rubber samples which I secured in the Amazon from trees the identity of which was established and has been authenticated through herbarium specimens.

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1. *Notes on the specimens of Hevea in the
De Candolle Herbarium*

Although there are larger and more comprehensive collections of *Hevea* in several European and American herbaria, it is true I think, that one of the most uniquely significant is contained in the De Candolle Herbarium in the Conservatoire Botanique in Geneva.

The intensive and extensive field studies and collections which Richard Spruce carried out a century ago in the Amazon Valley laid the first solid foundation for our understanding of the genus of the commercial rubber tree. Bentham's critical treatment of Spruce's material set the pace for later taxonomic work in the group. But the first attempt at a monographic synopsis of *Hevea* was that of Mueller of Aargau, working in Geneva.

Notwithstanding the fact that Mueller had access to a number of collections of *Hevea* in the Delessert Herbarium in Geneva and in other European institutions, we may regard the specimens preserved in the De Candolle Herbarium as representing the core of his study material. These were, in large part, the basis of his treatment of *Hevea* in De Candolle's Prodrômus 15, pt. 2 (1866) 717-719. Partly because of this association, the specimens and Mueller's handwritten annotations which some of them bear are worthy of special attention. Few of the specimens are rare; on the contrary, most of them are Spruce collections and are rather well distributed amongst the major herbaria of the world. This in itself is an additional reason for a close examination of those sets which have been, in a way, authenticated by the work of that great master of the *Euphorbiaceae*.

The arrangement of the species in the De Candolle Herbarium follows the order of their publication in the Prodrômus. Thus, the material of *Hevea* can be found

in the order in which the species are enumerated in the *Prodromus* 15, pt. 2 (1866) 717-719. In this article, I have followed Mueller's subgeneric division of *Hevea* into *Bisiphonia* and *Euhevea*, now no longer accepted, and I have employed the binomials used by Mueller regardless of the modern status of these names. This I have done so that the following notes will correspond with the arrangement of the material in the De Candolle Herbarium. In each case, however, I have indicated the annotation which I made in June 1950, so that there should be no difficulty in finding the present-day equivalent of the older binomials in those few cases where there has been some change. I wish to thank Dr. Charles Baehni, Director of the Conservatoire Botanique and other members of this institution for their kind help during my visit in June 1950.

BISIPHONIA

***Hevea Spruceana* (Benth.) Mueller-Argoviensis** in *Linnaea* 34 (1865) 204.

Siphonia Spruceana Bentham in Hooker's Journ. Bot. 6 (1854) 370.

There is one specimen under *Hevea Spruceana*, a duplicate type.

BRAZIL: Estado do Amazonas, Rio Amazonas, "In vicinibus Santarem, Prov. Pará. Coll. R. Spruce, Jul. 1850." [This date, printed, has been altered to read "1851."]

***Hevea discolor* (Benth.) Mueller-Argoviensis** in De Candolle Prodr. 15, pt. 2 (1866) 717.

Siphonia discolor Bentham in Hooker's Journ. Bot. 6 (1854) 369.

There are three specimens under this name, including a duplicate type of the species. I have annotated all three as *Hevea Spruceana*.

BRAZIL: Estado do Amazonas, Rio Solimões, near Ega [now called Teffé] [fide Mueller in Prodr. 717, no. 2] 1834, *Poeppig* 2595.

Consisting of several leaves and flowering inflorescences, this specimen is labelled "Perou? *M. Poeppig* 1834." In a small envelope containing flowers, there is a label "2595." For our information that the specimen was collected "prope Ega," we are indebted to Mueller, for there is no indication on the sheet that this was its locality. In fact, it is very probable that the concept represented by *Poeppig* 2595 does not occur in Peru, for it has apparently never been found in that country (cf. Seibert in Ann. Mo. Bot. Gard. 34 (1947) 261). Teffé (or Ega) represents almost the westernmost extent of *Hevea Spruceana*.

BRAZIL: Estado do Amazonas, Rio Negro, "de vicinibus Barra [now called Manãos], Prov. Rio Negro. Coll. *R. Spruce*. Dec.-Mart. 1850-51."

Originally determined as "*Siphonia elastica* Pers.?,", this collection represents that expression of *Hevea Spruceana* which is most abundant near the mouth of the Rio Negro. It is in fruit and has several beautiful seeds very typical of the *Hevea Spruceana* of the Manãos area: long, considerably flattened, with two very conspicuous flat surfaces ventrally, almost diamond-shaped in cross section, measuring 35 mm. long, 12 mm. thick, 17-18 mm. wide. There are also a number of valves of the capsule.

BRAZIL: Estado do Amazonas, Rio Amazonas, "ad oram septentrionalem flum. Amazonum, ad ostium Rio Negro. Coll. *R. Spruce* 1171. Aug. 1851."

Spruce 1171 is the type collection of *Siphonia discolor* (cf. Schultes in Bot. Mus. Leaflet. Harvard Univ. 15 (1952) 253. It represents the same expression of *Hevea Spruceana* as the collection previously discussed.

Hevea pauciflora (*Spruce ex Benth.*) *Mueller-Argoviensis* in *Linnaea* 34 (1865) 203.

Siphonia pauciflora Spruce ex Benth. in Hooker's *Journ. Bot.* 6 (1854) 370.

There is apparently no material of this concept in the De Candolle Herbarium.

Hevea rigidifolia (*Spruce ex Benth.*) *Mueller-Argoviensis* in *Linnaea* 34 (1865) 203.

Siphonia rigidifolia Spruce ex Benth. in Hooker's *Journ. Bot.* 6 (1854) 371.

There is one specimen of *Hevea rigidifolia*, a duplicate type.

BRAZIL: Estado do Amazonas, Rio Uaupés, "prope Panuré [Ipanoré] ad Rio Uaupés. Coll. *R. Spruce* 2527. Oct. 1852-Jan. 1853."

Spruce 2527 in the De Candolle Herbarium comprises a branch with several adult and young leaves and abundant flowering material. An examination of one staminate and one pistillate flower from the collection indicates agreement with the descriptions of this concept prepared on the basis of a recent study of the type and new material (Schultes in *Bot. Mus. Leaflet*, Harvard Univ. 13 (1948) 101, t. viii).

Hevea Benthamiana *Mueller-Argoviensis* in *Linnaea* 34 (1865) 204.

The specimen of *Hevea Benthamiana* in the De Candolle Herbarium is apparently the type of the concept.

BRAZIL: Estado do Amazonas, Rio Uaupés, "prope Panuré [Ipanoré] ad Rio Uaupés. Coll. *R. Spruce* 2560.

This material comprises four or five leaves and two axes of the inflorescence. It was formerly confused with *Hevea Spruceana* and was distributed as *Siphonia discolor*, but Mueller, recognizing it as a distinct concept, described it on the basis of this specimen.

Hevea brasiliensis (*Willd. ex A. Juss.*) **Mueller-Argoviensis** in *Linnaea* 34 (1865) 204.

Siphonia brasiliensis Willdenow ex Adr. de Jussieu Euphorb. Gen. (1824) t. 12, pl. 38b, fig. 1-6.

The De Candolle Herbarium has two collections of this species, one of which is a fragment of the type.

BRAZIL: Estado do Pará, Rio Amazonas, "Pará Hoffmannsegg."

The Hoffmannsegg material of this concept, collected probably at the mouth of the Amazon by Sieber, is that on which the earliest publication of the binomial *Siphonia brasiliensis* and Willdenow's accompanying diagnostic plate were based (cf. Schultes in Bot. Mus. Leaflet. Harvard Univ. 14 (1950) 79). The type is in the Willdenow Herbarium in Berlin; there is a duplicate type in Paris (Schultes l.c. Pl. xix). In an envelope on the sheet labelled *Hevea brasiliensis* in the De Candolle Herbarium, there are two leaflets of this Sieber collection; the envelope is marked, in Mueller's hand: "Folia: Para: Hoffmannsegg."

BRAZIL: Estado do Pará, Rio Amazonas, "Para, Spruce, 1849."

This second collection of *Hevea brasiliensis* consists of two complete leaves and several inflorescence axes in good flower. It is the widely distributed collection which Spruce made in the region of Belém do Pará shortly after his arrival in South America in 1849; since, in Pará, *Hevea brasiliensis* flowers in August and early September, we may assume that this collection was one of the first which Spruce, who arrived in mid-July, 1849, made in South America. It can be considered topotypical; and, indeed, it matches the type extremely well.

Mueller has written an annotation to the effect that this Spruce specimen was acquired "ex hb. Van Huerck." The Van Huerck Herbarium is incorporated in the col-

lection at the Natuurwetenschappelijk Museum in Antwerp, Belgium, where there is an excellent specimen of this Spruce collection of *Hevea brasiliensis* and where, on a Sagot collection of *H. guianensis* Aubl. from French Guiana, I found the following interesting annotation: [ex herb. DC contre un fragment de *H. brasiliensis* Muell.-Arg.].

***Hevea lutea* (Spruce ex Benth.) Mueller-Argoviensis**
in Linnaea 34 (1865) 204.

Siphonia lutea Spruce ex Bentham in Hooker's Journ.
Bot. 6 (1854) 370.

The De Candolle Herbarium possesses two specimens which Mueller referred to *Hevea lutea*. I have annotated both as *Hevea guianensis* Aublet var. *lutea* (Spruce ex Benth.) Ducke & Schultes.

VENEZUELA: Territorio del Amazonas, Río Negro, "prope San Carlos, ad Río Negro, Brasiliae borealis. Coll. R. Spruce 3139, 1853-54."

Spruce 3139 is widely distributed in the principal herbaria. The De Candolle specimen, a duplicate type of *Hevea apiculata* Baillon, is especially complete, comprising several leaves, a few loose leaflets and abundant flowering material. Mueller, who, in the Prodrumus (l.c. 719), reduced *Hevea apiculata* to synonymy under *H. lutea* and who later (in Martius Fl. Bras. 11, pt. 2 (1874) 302) made it a variety of *H. lutea*, wrote on the specimen: "Non differt a *Hevea lutea* Muell.-Arg. 1863. β *apiculata* Muell.-Arg. in Flor. bras."

BRAZIL: Estado do Amazonas, Rio Uaupés, "prope Panuré [Ipanuré] ad Rio Uaupés. Coll. R. Spruce 2088. Oct. 1852-Jan. 1853."

The De Candolle Herbarium material of *Spruce 2088*, a duplicate type of *Siphonia lutea*, is an especially complete flowering specimen of a widely distributed number.

Hevea guianensis Aublet Hist. Pl. Guyan. 2 (1775) 871.

There are two collections in the De Candolle Herbarium which Mueller refers to this concept. I have annotated them both as *Hevea guianensis*.

FRENCH GUYANA: 1840, *Leprieur*.

The Leprieur collection, represented also at Paris, seems to be the earliest flowering material of *Hevea guianensis*. Mueller has left a label in his handwriting, which reads: "Euphorbiae. Calyx ad mediam usque 5-partitus, petala nulla, stam 5! circa rudimentum ovarii in columnam coalita, filamenta subnulla, fol. stipulata."

FRENCH GUYANA: Maroni, 1857, *P. Sagot* 510.

The Sagot collection is represented in several herbaria. The specimen in the De Candolle Herbarium is in abundant flower.

2. *Miscellaneous notes, chiefly on specimens of Hevea in various European herbaria*

Hevea brasiliensis (Willd. ex A. Juss.) Mueller-Argoviensis in Linnaea 34 (1865) 204.

BRAZIL: [Near mouth of Rio Amazonas] *Sieber* s.n. [?]

The Humboldt Herbarium in Paris has a collection referable to *Hevea brasiliensis* and consisting of one leaflet and several flowers in a little packet. The packet is labelled "*Siphonia brasiliensis* W. (e specim authent. ab ipso Willdenow misso)," and is evidently a fragment from the type specimen in the Willdenow Herbarium collected by Sieber, which it matches perfectly (cf. Schultes in Bot. Mus. Leaflet. Harvard Univ. 14 (1950) 79).

In this same herbarium, there is a full specimen which

likewise matches the type. Unfortunately, it bears no data concerning the locality or date of collection nor a collector's name, but I believe it to be a duplicate type. The only annotation it bears is the following: "dedit Willdenowius, 1811."

***Hevea guianensis* Aublet** Hist. Pl. Guian. 2 (1775) 871.

In the Paris Herbarium, there are two sheets of *Hevea guianensis* upon which is written: "Leg. A. Richard. Sta. Martha Antilles. *Siphonia elastica* ex hb. de Franqueville. Herb. E. Cosson 18." The special interest attending these particular specimens centers on the locality data. The only "Sta. Martha" which I have been able to find registered for the entire Antillean area is the very old city of that name on the Caribbean coast of Colombia. The genus *Hevea*, of course, is unknown from that region, and we may very safely assume that it does not exist there in a natural state.

I believe this to be an erroneous annotation. The specimen corresponds so very closely to other material of *Hevea guianensis* from French Guiana (including specimens also collected by Richard) that I am convinced that it was collected in that colony. Louis Claude Richard, who was commissioned in 1781 to carry out explorations in French Guiana and the Antilles, spent much of his time in French Guiana, later travelling in Martinique, Guadeloupe, Jamaica, St. Thomas, and some of the islands in the Gulf of Mexico (cf. Lasègue "Musée Botanique de M. Benjamin Delessert" (1845) 474). *Hevea* is known in a native state in none of these areas except French Guiana.

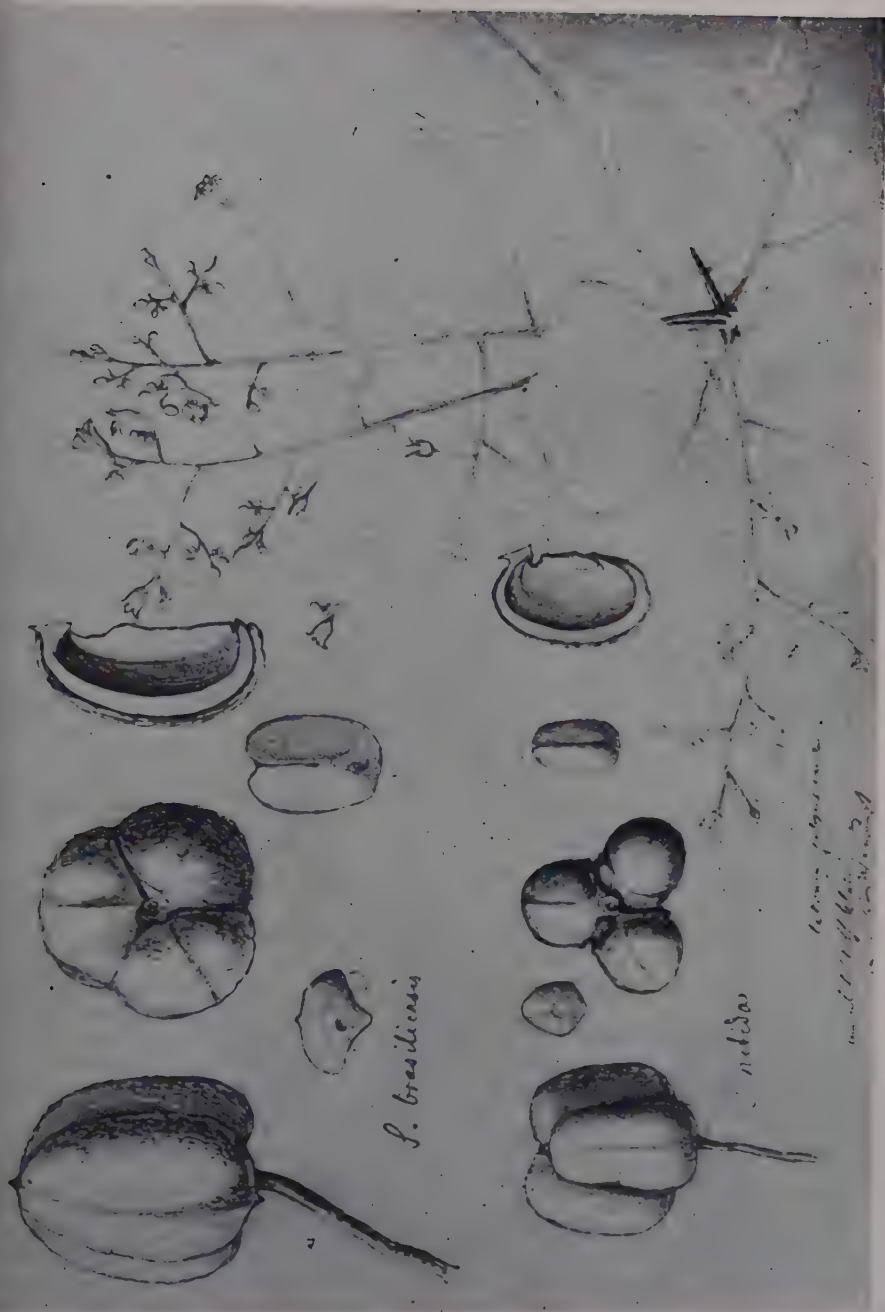
Hevea guianensis* Aublet** var. ***lutea (Spruce ex Benth.) Ducke & Schultes in *Caldasia* 3 (1945) 249.

EXPLANATION OF THE ILLUSTRATION

PLATE I. Reproduction of a page from Martius' notes, preserved in the Munich herbarium. The manuscript description of *Siphonia nitida* Martius may be seen at the top of the page. I wish to thank the officials — especially Dr. Otto Renner and Dr. Th. Suessengurth — for making available for publication this interesting historical manuscript.

EXPLANATION OF THE ILLUSTRATION

PLATE II. Photograph of the drawing (by Martius?) of *Siphonia nitida* Martius in the herbarium of the Botanische Staatssammlung in Munich. In view of the fact that, until recently, the concept *Hevea nitida* has not been understood and that no reproduction of the fruiting portions of the type specimen has ever been published, it has seemed advisable to reproduce this drawing, with the kind permission of the officials of the Munich herbarium.



Hevea andenensis C. F. Jones "South America" (1940) 222.

In his book "South America," Clarence F. Jones has published what would appear to be a *nomen nudum*—*Hevea andenensis*—in a passing reference to the source of Peruvian rubber. Although this publication can in no way be considered as a natural history and although no specimens were cited, the binomial may be picked up by some of the many non-technical writers who are presenting works on various studies in Latin American affairs. In order to preclude any confusion which might result from the perpetuation of the *nomen nudum*, the present note appears to be advisable.

We are not certain, of course, as to the exact concept which Jones had in mind when he used the binomial. Jones speaks of the plant as growing at a high altitude. Seibert (in Ann. Mo. Bot. Gard. 34 (1947) 293) states that "*Hevea guianensis* in pure strain appears to have been collected rarely in Perú" but (l.c. 294) that *H. guianensis* var. *lutea* "is a characteristic tree of the Peruvian *montaña*" and "is found on much of the Peruvian *tierra altura* [sic] and hilly land of the Peruvian Amazon basin . . . on the eastern Andean foothills, occasionally as high as 5000 feet." In view of this, I believe that we are justified in referring *Hevea andenensis* to *H. guianensis* var. *lutea*.

It is possible that Jones' binomial is an incorrect rendering of another *nomen nudum*—*Hevea andinensis* Sperber (in Tropenfl. 14 (1910) 96)—but there is no evidence that this is the case.

***Hevea nitida* Martius ex Mueller-Argoviensis** in Martius Fl. Bras. 11, pt. 2 (1874) 301.

BRAZIL: "In silvis secundum fl. Solimões et Amazonicum" [1819], Martius s.n.—"Prov. do Alto Amazonas. In silvis secundum. Solimões

et Amazonum" [1819] *Martius s.n.* — "In silvis Japurensibus" [1820], *Martius s.n.*

In the herbarium in Munich, there are four Martius specimens of *Hevea nitida*, but only three different labels for the four specimens. Since the collections are not numbered, we cannot say whether or not Martius made three collections or merely one as has hitherto been presumed. After a study of the material in Munich, I am inclined to believe that there are two distinct collections; one, represented by three specimens, from the Rio Amazonas somewhere above the mouth of the Rio Negro (which section of the Amazon is known in Brazil as the Rio Solimões); the other, represented by a single specimen, from the Rio Japurá. We know that this highly local species is found on both rivers in localities where Martius collected: São Paulo de Olivença (on the Solimões); La Pedrera or Cupatí (on the Japurá).

In 1930, Dr. Francis Macbride of the Field Museum photographed type specimens in Europe. His photograph No. 6631 represents a specimen of the second "collection" cited above. In the middle of the last century, the type concept was not a guiding principle of taxonomy and Martius undoubtedly based his description on more than one specimen. If we are to choose a type, however, I should elect one of the two specimens which I have cited above as the first "collection." One of these specimens seems to have been awarded more attention by Martius and Mueller than the others, for Martius wrote on it: "*Siphonia nitida* Mart." and Mueller annotated it as "*Hevea nitida* J. Muell." The other specimens are not so annotated. Furthermore, for this specimen there are seeds and capsules in the fruit collection. For these reasons, then, I have labelled this specimen and not the one represented by Macbride's photograph as the type.

There is in the Munich Herbarium an unfinished draw-

ing of *Hevea nitida*. Whether or not this drawing was executed by Martius himself or merely under his direction, I have not been able to ascertain. Since it is unfinished, it has hitherto never been published (Plate II).

Other specimens of the Martius collection(s) of *Hevea nitida* are found in the Herbarium Delessert in the Conservatoire Botanique in Geneva and in the Rijksherbarium in Leiden. The Geneva specimen bears the following information: "Solimões et Amazonium fluv." The Leiden material is labelled "Brasilia pr. Rio Negro" and was acquired by exchange from the Munich Herbarium. There is an unusually complete set of Martius plants in Brussels, but I found no specimen of *Hevea nitida* there.

Hevea nitida was, for many years, surrounded by much uncertainty. Ducke (in Arch. Inst. Biol. Veg. Rio Janeiro 2 (1935) 243) and Schultes (in Bot. Mus. Leaf. Harvard Univ. 12 (1945) 7) each held different opinions. In 1947, using new characters which he found very useful in the study of *Hevea*, and on the basis of Macbride's photograph, Seibert (in Ann. Mo. Bot. Gard. 34 (1947) 298) maintained that *Hevea nitida* and *H. viridis* Hub. were identical and reduced the latter to synonymy under the former. Schultes (in Bot. Mus. Leaf. Harvard Univ. 13 (1947) 10 and Baldwin (in Journ. Hered. 40 (1949) 48) accepted Seibert's change. It is apparent from my examination of the Martius material that Seibert's opinion is correct. Not only do all of the vegetative characters of *Hevea nitida* correspond exactly with those given for *H. viridis*; the seeds and capsules which are preserved in Munich alone furnish sufficient evidence that *H. nitida* is the same concept which has been masquerading under the name *H. viridis*.

Hevea pauciflora (*Spruce ex Benth.*) *Mueller-Argoviensis* in Linnaea 34 (1865) 203.

Siphonia Kunthiana Baillon Étude Gén. Euphorb. (1858) 326.

VENEZUELA: [Upper Orinoco basin, 1800], *Bonpland* 5022.

The type of *Siphonia Kunthiana* in the Humboldt Herbarium in the Musée d'Histoire Naturelle in Paris is sterile, consisting of but three leaflets. The tip of only one of the three is preserved, but it shows the calloused glandular tip which is characteristic for the species. The longest leaflets measure 22–24 cm. long, 7.5–8 cm. wide. They are elliptic, long-acuminate and very membranaceous.

DUTCH GUIANA: Boschreserve, Sectie O, Boomnummer 41, November 10, 1916, *Forestry Bureau* 2368.

FRENCH GUIANA: 1857, *P. Sagot* (pro parte).

In Paris, there are two sheets marked "Hb. Sagot 510" and they represent different concepts. One, labelled "Maroni, ile portal 1857," is undoubtedly *Hevea guianensis*; but the other has larger leaflets of a different shape, with the glandular-calloused tip and the type of scales on the lower surface which are so characteristic of *H. pauciflora*.

I think that we may safely refer this second specimen, even though it be sterile, to *Hevea pauciflora*, and I have so annotated it. It bears the annotation "Hb. Sagot 510. Le caoutchouc. Acarouany. (Guyana fraise. 9^e 1854, in silvis humidis.) *P. Sagot*."

This is not the first time the identity of the specimen in question has been the subject of discussion. A letter from Dr. P. J. S. Cramer, dated March 3, 1913, is attached to the specimen. It states: "This specimen differs much from the others which show well the characteristics of *Hevea guyanensis* (obtuse leaf, rounded buds). The leaflets approach most closely *Hevea brasiliensis* . . . It

seems to me that the reason may be that this specimen was collected from a young plant; the texture of the leaves also indicates this. On all young plants one finds near *Hevea guyanensis*, the typical characters do not appear; they also have leaves characteristic of *Hevea brasiliensis*."

Credit must go to Cramer for his perspicacity, but the suggestion that the specimen is referable to *Hevea brasiliensis* cannot be accepted in view of the characters exhibited in the tip and scales.

This is apparently the first time *Hevea pauciflora* has been recorded for the flora of French Guiana. Hitherto, the only species known from that colony was *Hevea guianensis*.

Similarly, till now *Hevea pauciflora* has never been reported from Dutch Guiana, although it is not uncommon in adjacent British Guiana. I have found a Surinam specimen in the herbarium at Utrecht which seems to represent this species. It is sterile, but the tip of the leaflet shows it to belong to *Hevea pauciflora*, not to *H. guianensis*.

***Hevea pauciflora* (Spruce ex Benth.) Mueller-Argoviensis** var. ***coriacea* Ducke** in Arch. Inst. Biol. Veg. Rio Janeiro 2 (1935) 239.

BRITISH GUIANA: August 1843, *Richard Schomburgk 1381*.

The specimen of this collection which is preserved in the Humboldt Herbarium in Paris was annotated with an unpublished name in *Siphonia* honoring Schomburgk. The annotation seems to have been made prior to 1865, for since that year the generic name *Hevea* has been universally accepted by all who have worked seriously with the group. I was unable to ascertain in whose handwriting the annotation was written. It is significant in being

apparently the earliest recognition of this distinct concept, antedating Hemsley (*Hevea confusa*) and Ducke (*H. pauciflora* var. *coriacea*) by many years (cf. Schultes in Bot. Mus. Leaf. Harvard Univ. 15 (1952) 264.

Hevea rigidifolia (*Spruce ex Benth.*) *Mueller-Argoviensis* in *Linnaea* 34 (1865) 203.

COLOMBIA: Comisaría del Vaupés, Río Guainía basin, Río Naquieni, at base of Cerro Monachí. Caatinga forest. June 1948, *Richard Evans Schultes & Francisco López 10112*; Same locality and date. *Schultes & López 10118, 10119, 10120, 10122, 10130*.

This most unusual species of *Hevea*, recently rediscovered after the passing of a century (cf. Schultes in Bot. Mus. Leaf. Harvard Univ. 13 (1948) 97), has hitherto been thought to occur only in Brazilian territory. It was naturally to be expected in adjacent regions of Colombia and was so indicated in an enumeration of species of *Hevea* in Colombia in 1945 (Schultes in Bot. Mus. Leaf. Harvard Univ. 12 (1945) 11).

Recent explorations in the upper Río Negro basin indicate that *Hevea rigidifolia* is rather widespread in a number of the affluent rivers of the right bank from the Río Curicuriarí northwards. It is extremely abundant in many of the caatingas of this region. Phytogeographically most noteworthy was the discovery of the species far upstream in the basin of the Río Guainía, at the base of the Cerro Monachí mass, in Colombian territory. The proximity of this locality to Venezuela would suggest the strong possibility that *Hevea rigidifolia* may also form a component of the caatinga forests of the Venezuelan Territorio del Amazonas. The discovery of *Hevea rigidifolia* in Venezuela would indeed be significant, as most of the waters drain into the upper Orinoco system instead of the Amazon.

Hevea Spruceana (*Benth.*) *Mueller-Argoviensis* in
Linnaea 34 (1865) 204.

In Everard im Thurn's widely consulted book "Among the Indians of Guiana" (1883) 238, it is stated "one tree thus attractive [seed used as bait] to fish is the Hatie 'india-rubber' plant (*Hevea Spruceana*)."

It would seem advisable to point out that *Hevea Spruceana* has never been collected in the Guianas and is known only in the Brazil Amazonia along the Amazon River itself below the mouth of the Putumayo (Iça) and along the lower course of its affluents.

In these earlier years, there was much confusion between *Hevea Spruceana* and *H. pauciflora* (Spruce ex Benth.) Muell.-Arg. An attempt to clarify this confusion led me, during my stay at the Royal Botanic Gardens, Kew, in 1950, to the discovery of several points of bibliographic interest which, since they are apparently not widely known, would seem to bear discussion and repetition in this series of miscellaneous notes on *Hevea*.

The confusion between *Hevea pauciflora* and *H. Spruceana* in British Guiana began in 1881 when Oliver (in Kew Rept. 1880 (1881) 37), assuming, for some unstated reason, that the inflorescences of the type material of *H. pauciflora* were abnormal, stated categorically that this concept is referable to *H. Spruceana* and that all of Jenman's collections likewise represented *H. Spruceana*. Oliver (l.c.) reported that this rubber had the following native names in British Guiana: Arawak—*haatie*; Carib—*po-muy*; Ackawoi—*sibisibi*.

G. S. Jenman, through whose extensive collections we know *Hevea pauciflora* var. *coriacea* as it occurs in British Guiana, took up Oliver's identification of his material as *H. Spruceana*. In his fascinating article entitled "A journey in search of 'Hevea Spruceana' with remarks on India rubber and gutta percha yielding plants

generally" (in Timehri 1 (1882) 44), Jenman quoted Oliver as follows: "With regard to the Heveas sent by Mr. Jenman (No. 621 and 725), I have examined them carefully and believe they both belong to the same species, and that they are identical specifically with *H. pauciflora* Muel. Org. [sic] *Siphonia pauciflora*, Bnth.) and *H. Spruceana* Muel. Org. (*Siphonia Spruceana* Bnth.). Of these two names, the latter should be adopted—the type specimen of *H. pauciflora* being evidently abnormal as to the inflorescence, and the plant flowering in copious panicles . . . The name to adopt here is *Hevea Spruceana* Muel. Org. This satisfactorily settles the identity of the plant."

These rubber trees were later described by Hemsley (in Hooker Ic. Pl. 6 (1898) t. 2570, t. 2575, figs. 1–3, 12–13) as *Hevea confusa*. As a synonym of *Hevea confusa*, he included "*H. Spruceana* Oliv. in Timehri, 1882, p. 50, non Muell.-Arg." It should be pointed out that, in reality, there is no *Hevea Spruceana* of Oliver, for Oliver himself definitely stated that he believed the specimens to represent *H. Spruceana* of Mueller-Argoviensis; the problem is nothing more than a mere misidentification of material.

Farther on in his book, Jenman (l.c. 51) offers an excellent ecological note on this *Hevea*: "They are very plentiful. The situation is a tract of low alluvial land along the bank of the river, which in the rainy season is quite submerged, often apparently deeply . . . The forest was high and dense, producing a gloomy shade within, and there was little undergrowth. The *Hevea* was scattered irregularly among other subjects. The plants varied much in size; the largest observed and measured did not exceed 18 to 21 inches in diameter, or from 40 to 60 feet in height. As a natural result of confinement in dense forest, the trunks were here straight and unbranched,

EXPLANATION OF THE ILLUSTRATION

PLATE III. *HEVEA MICROPHYLLA* Ule. Photograph of the tree (*Schultes & López 9593*) from which the leaf and bark material for the chemical analysis reported in this paper were collected.

Photograph by RICHARD EVANS SCHULTES

PLATE III



EXPLANATION OF THE ILLUSTRATION

PLATE IV. A view of the caatinga at Taracuaá, Rio Uaupés, Brazil, showing the abundance of *Hevea rigidifolia* (slender, columnar trees without buttress roots in center and background). These trees were tapped for rubber, the analysis of which is reported in the present article.

Photograph by RICHARD EVANS SCHULTES

PLATE IV



but on the banks of the river and creeks, a situation they seem to prefer, they are branched, much stouter and hardly erect, but lean out in the center, in the effort to steer clear of their close-growing neighbors . . . September is the flowering season, and April and May is, I think, the fruiting season."

3. Notes on chemical analyses of *Hevea* rubber samples

Hevea Benthamiana *Mueller-Argoviensis* in Linnaea 34 (1865) 204.

COLOMBIA: Comisaría del Amazonas, Río Cotuhé, near its mouth, near Tarapacá. "Small tree, basally swollen, tapering rapidly upwards. Bark externally dark brown, smooth; internally red; thin, peeling easily from cambium. Latex white, abundant. Leaflets reclinate. Flowers yellow, some bright red in lower half of calyx. *Seringa chicote*." September 8, 1946, *Richard Evans Schultes* 8123.—Río Putumayo, Tarapacá. "Leaflets strongly reclinate. Trunk 65 feet tall; basally swollen, 17 inches in diameter, rapidly tapering upwards. Bark very smooth, 5 mm. thick, soft, externally dark brown, internally reddish. Crown compact, heavy. Flowers yellow, reddish at base. Latex white, of medium thickness." September 9, 1946, *Richard Evans Schultes* 8125. Same locality and date, *Schultes* 8126, 8127.

A sample of smoke-cured rubber taken from an estrada of trees at Rapidol, on the left bank of the Río Putumayo at Tarapacá in Amazonian Colombia has been analyzed by Mr. A. V. McMullan of the Division of Rubber Plant Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, with the following results: "Resins (acetone extract) 2.60%; Rubber hydrocarbon (benzene extract) 92.99%; Insolubles 4.41%; Comments on character of dried benzene extract: Tough, strong and hard, similar to *brasiliensis*."

In the short-lived exploitation of wild rubber in Amazonian Colombia during the past war, rubber from the vicinity of Tarapacá was purchased by the Rubber Development Corporation as the equivalent of "Up-River" (a relatively high grade of *Hevea brasiliensis* rubber).

I have examined several hundred trees in the estradas which produced the sample analyzed and have found that they represent rather typical *Hevea Benthamiana*. There is no *Hevea brasiliensis* in the Putumayo watershed.

***Hevea guianensis* Aublet var. *lutea* (Spruce ex Benth.) Ducke & Schultes** in *Caldasia* 3 (1945) 249.

BRAZIL: Estado do Amazonas, Rio Negro near mouth of Rio Issana. April 7, 1948, *Richard Evans Schultes & Francisco López 9784A*.

In the upper Rio Negro basin, very little exploitation of *Hevea guianensis* var. *lutea* has been carried out because of the great abundance of *H. Benthamiana* which is preferred. An analysis of air-dried scrap from the tree represented by *Schultes & López 9784A* gave the following results: "Resin (acetone extract) 4.97%; Rubber hydrocarbon (benzene extract) 86.42%; Insolubles 8.61%; Softer, less strong and tough in comparison to *brasiliensis*." An analysis of the bark from this tree gave the following results: "Resin (acetone extract) 1.34%; Rubber hydrocarbon (benzene extract) 1.25%. Compares favorably with crude rubber from some species."

***Hevea microphylla* Ule** in *Engler Bot. Jahrb.* 35 (1905), t. 1:j, k, l, m; in *Kautschukgewinnung (Kolonialwirtsch. Kom. 1905)* (1905) 10.

BRAZIL: Estado do Amazonas, Rio Negro, São Felipe, below mouth of Rio Issana. "Small, whip-shaped tree, basally swollen. Basal diameter 9 inches, height 40 feet. Leaflets horizontal to slightly reclinate. Latex sparse, white, thin, not easily coagulating. Bark of terminal branches red, smooth; of trunk, dark brown-red outside, whitish inside, thin, hard, peeling readily. Wood extremely soft, white. 46 rings." January 8, 1948, *Richard Evans Schultes & Francisco López 9593*.

Ample material of the bark and leaves of this tree was taken for chemical analysis. The latex of *Hevea microphylla* is, in general, extremely thin and coagulates be-

tween the fingers to a sticky mass of little elasticity. The tree is never tapped by the natives, not even for adulterating the latex of *Hevea Benthamiana*, because, according to the rubber workers, the latex of the "seringueira tambaqui" (*H. microphylla*) often acts as an anti-coagulant when mixed with that of *H. Benthamiana*.

In view of this, one result of Mr. McMullan's analysis is extremely interesting. The bark of *Schultes & López 9593* gave the following analysis: "Resin (acetone extract) 1.78% ; Rubber hydrocarbon (benzene extract) 0.97%. Good rubber in comparison with *brasiliensis*." The leaves, when studied, gave the following analysis: "Resin (acetone extract) 6.83% ; Rubber hydrocarbon (benzene extract) 0.81%. Typical leaf rubber, soft, tacky and weak." It would appear from this study that the composition of the latex from different parts of one individual of *Hevea microphylla* can vary rather appreciably.

***Hevea nitida* Martius ex Mueller-Argoviensis** in Martius Fl. Bras. 11, pt. 2 (1874) 301.

BRAZIL: Estado do Amazonas, Rio Negro, Serrinha, opposite mouth of Rio Issana. Caatinga. January 7, 1948, *Richard Evans Schultes & Francisco López 9586*.

In several caatingas in the upper Rio Negro basin, I saw evidence that, in the rubber boom of the past war, *Hevea nitida* was cut for a few days or weeks and was then abandoned. Trees at the confluence of the Rio Negro with the Rio Uaupés and at Serrinha had from three to ten incisions. It is probable that natives, many of whom at the start of the rubber boom were unfamiliar with *Hevea nitida*, were attracted by the great density of this species in the caatinga formation and began to gather latex from it. Since the latex of *Hevea nitida* (formerly known as *H. viridis* Huber) has the reputation, not only of giving a worthless rubber, but also of "poisoning" the

latexes of other species and preventing their coagulation (Schultes in Bot. Mus. Leaflet. Harvard Univ. 12 (1945) 11; Seibert in Ann. Mo. Bot. Gard. 34 (1947) 269), it is probable that the natives gave up the exploitation of their caatinga trees upon discovery of this characteristic of *H. nitida*.

Material for chemical study was taken from bark and leaves of the tree which supplied the herbarium collection Schultes & López 9586. The analyses of this material are as follows: Bark—"Resin (acetone extract) 2.57% ; Rubber hydrocarbon (benzene extract) 0.64%. Poor, soft, sticky." Leaves—"Resin (acetone extract) 10.52% ; Rubber hydrocarbon (benzene extract) 0.77%. Typical leaf rubber."

***Hevea pauciflora* (Spruce ex Benth.) Mueller-Argoviensis** in Linnaea 34 (1865) 203.

BRAZIL: Estado do Amazonas, Rio Negro, Carapaná (above confluence of Rios Negro and Uaupés). "Tree 55 feet tall, columnar, 18 inches in diameter. Latex light yellow, thick, coagulating to a poor rubber. Bark externally smooth, light tan-brown, inside whitish, thick, hard. Flowers borne before old leaves fall. Staminate flowers open cupuliformly, yellow but red line running up centre of sepals internally and short red lines at junctions of sepals. Leaflets thick chartaceous, horizontal. Seed valves very large." November 30, 1947, Richard Evans Schultes & Francisco López 9194.

At the little hamlet of Carapaná, a few kilometers upstream from the confluence of the Negro and the Uaupés, there is a small planting of trees of *Hevea pauciflora*. The collection cited above was made from this colony.

These trees were tapped and an air-dried sample of the rubber was submitted to the National Bureau of Standards in Washington for analysis. The results of this analysis are significant. Dr. Lawrence A. Wood reported (Letter and report, Dr. Lawrence A. Wood to Dr. R. D. Rands, November 7, 1949) that: "The sample was given

the rating of Grade III (fair) based on the system used at the National Bureau of Standards for grading wild rubber." (For details of this system, reference is made to Rubber Age 62 (1947) 173). Further notes in the analysis are: "Shrinkage on washing and drying 13.5%. Mooney viscosity 17.5. Resins (acetone extract) 17.1%; rubber hydrocarbon 80.4%; insoluble materials 2%." The sample, after vulcanization for 45 minutes (optimum cure) at 141°C according to the ACS II test formula, had the following tensile physical characteristics: ultimate elongation 685%; tensile strength 1885. The elongation at 200 psi was 251%.

Hevea rigidifolia (*Spruce ex Benth.*) *Mueller-Argoviensis* in Linnaea 34 (1865) 203.

BRAZIL: Estado do Amazonas, Rio Uaupés, Taracúá. Caatinga. February 3-6, 1948, *Richard Evans Schultes* 9673, 9678, 9680.

The rubber from *Hevea rigidifolia* has the reputation of being of a very poor quality. Indeed, a rapid examination in the field can convince the investigator of the soundness of this reputation. There seems, however, to be something more complex than would appear on superficial examination. This is brought out by the unexpected results of Mr. McMullan's analysis of an air-dried sample of rubber which I obtained by tapping twenty-six trees of *Hevea rigidifolia* in the extensive caatinga behind the settlement of Taracúá on the Rio Uaupés, near the mouth of the Rio Tikié. The collections cited above are from three of the individuals which were tapped. Mr. McMullan's analysis follows: "Resin (acetone extract) 3.36%; Rubber hydrocarbon (benzene extract) 95.01%; Insolubles 1.63%. Appeared to be somewhat stronger and harder than *guianensis*."

BRAZIL: Estado do Amazonas, Rio Uaupés, Ipanoré. Caatinga. February 2, 1948, *Richard Evans Schultes* & *Francisco López* 9665.

Samples of the bark and leaves of an individual of *Hevea rigidifolia* from Ipanoré were gathered for chemical examination. Ipanoré is the type locality of this species. It is very interesting to compare the analysis of the bark and leaf of this plant with that of the air-dried rubber specimen from Taracuá, a locality only a few miles east of Ipanoré. *Schultes & López 9665* gave the following analysis: "Bark—Resin (acetone extract) 7.85% ; Rubber hydrocarbon (benzene extract) 0.00 Leaves—Resin (acetone extract) 27.16% ; Rubber hydrocarbon (benzene extract) 1.28%. Poor, typical leaf rubber."

It is probable that more analyses of rubber samples taken in the field from wild populations and authenticated by identifiable herbarium material might furnish us with extremely significant information relative to such variations within a species from the same general region.